DOCUMENT RESUME

ED 136 213 CS 003 263

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TITLE A Behavioral Analysis of an Early Reading Program.
PUB DATE 77
NOTE 14p.; Paper presented at the Annual Meeting of the American Educational Research Association (New York, New York, April 1977)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Beginning Reading; *Behavioral Science Research; Primary Education; Programed Instruction; *Reading Instruction; *Reading Programs; *Reading Research; Theories
IDENTIFIERS New Primary Grades Reading System

ABSTRACT

The development of a psychology of instruction calls for qualitative, as well as quantitative, information about curriculum components. An analysis of selected instructional sequences of the New Primary Grades Reading System, a reading acquisition curriculum for five and six year olds, was performed by applying appropriate category systems from several theoretical models. The purpose of the study was to examine the conditions of learning which had been built into the instructional sequences that present new content. The results demonstrate and make more explicit one designer's mode of introducing behavioral learning principles into sequences of a structured curriculum. The analysis makes evident four main principles of instruction: (1) making explicit use of knowledge about the capabilities of the learner for whom the materials have been designed; (2) structuring language units so that they can be readily grasped by the learner; (3) identifying a progression of effective sequence types; and (4) specifying the contingencies of reinforcement. Taken together, the strategies of instruction implicit in the design of the curriculum constitute a theory of instruction in reading acquisition. (Author/AA)

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American Educational Research Association Meeting
New York, April, 1977

A Behavioral Analysis of an Early Reading Program

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This study reports the results of a systematic analysis of selected products of the New Primary Grades Reading System (NRS), a structured, experimental program of reading acquisition for five- and six-year-olds, designed at the Learning Research and Development Center of the University of Pittsburgh (Beck and Mitroff, 1972). The purpose of the study is to make explicit certain strategies of instruction which are implicit in selected structured products of this reading curriculum. In this way, more precise knowledge of the nature of the planned sequence as it actually appears in the instructional products is made available.

The content being analyzed is the curriculum structure defined by constructs from behavioral learning theory. The focus is on reading acquisition skills which differ from skills required of the mature and proficient reader. The analysis seeks to identify the instructional strategies which bring elements of written language to be learned, learner behavior, and presentation mechanisms together in a way that facilitates a young child's learning to read. In order to perform this analysis, a methodology was developed for determining the conditions of learning to read which are inherent in the NRS products. This methodology serves the purpose of articulating the prescriptive theory which has been designed into the instructional sequences of NRS.

Method and Theoretical Framework

Behavioral analysis of classroom learning was pioneered by E. L. Thorndike (1922), developed further by Skinner (1953) and applied to the building of learning hierarchies by Gagné (1962) and others. In this tradition, Glaser (1962) presented a basic teaching model. Holland (1965) carried out careful research

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on programming variables, and later (Holland, 1967) presented a "blackout technique" for assessing the efficiency of programmed materials. More recently, Holland+Doran (1973) have elaborated the basic Skinnerian learning model to include five elements to be considered for contingency management.

The method used in this study is one of successive imposition of theoretical models upon the design of the instructional products. A basic teaching model of Glaser (1962) is used to limit the analysis to the instructional procedures only. By means of sorting rules, instructional products are identified. The unit of time chosen is one school year (grade one); the curriculum unit is the classroom. Instructional products analyzed are selected from the entire array of products available for classroom use. Taking the designer's organization scheme, the instructional procedures are further limited to those in the vertical progression of behavioral objectives where new content and skills are taught (Beck and Mitroff, 1972, p. 37). Tosti and Ball's (1969) model for identifying dimensions of stimulus and response at the level of a lesson in the curriculum is used as a point of departure for the detailed analysis of the instructional events within MRS. For the analysis of initial instruction, selected sequences are identified by response types after the categories given by Holland and Doran (1973). A decoding hierarchy developed by Gagné (1965) and several acquisition models of reading (Williams, 1973) are applied to the analysis of decoding techniques in MRS. Two basic comprehension tasks, word scanning and pattern scanning, are identified from the categories available from several different comprehension taxonomies (Davis, 1968, Auerbach, 1971, Carroll, 1972).

The fine-grain analysis of each instructional sequence type is carried out by using two basic procedures. First, within the individual sequence, the four elements of the Glaser (1962) teaching model are identified. Second, the basic Skinnerian learning model as elaborated by Holland and Doran (1973) is used to

identify the elements for contingency management within each sequence. Programming variables are the specific objects of interest within this part of the analysis.

From the identification of these elements found in various theoretical models selected, some generalizations are formulated. These are then articulated as strategies of instruction for learning how to read.

For the assessment of the effectiveness of the design of the materials, two procedures are used. An application of the blackout technique helps in judging the sequences for contingency management. Analysis of Progress Checks gives information about retention of material taught and the occurrence and types of errors.

Limitations in this method must be taken into account. A Skinner-Holland approach views instruction chiefly as a management process. Knowledge is equated with behavior and no attempt is made to describe events in the learner's conceptual system. Cognitive models of learning are not used. Programming variables are the elements of interest; i.e., stimuli, responses, and straightforward relationships between these. Attention is paid to shaping behavior by gradual progression and successive approximations, prompting and fading of prompts. Active responding should give evidence of proper discriminative behavior. These constitute the conditions of learning being investigated. Basically, the method is one of matching instructional variables with experimental variables identified in various theoretical models. This procedure is based on the assumption that experimental variables and scientific methods can be translated into the classroom setting and still retain validity. The key concepts that guide the process are task analysis and sequencing for contingency management.

In summary, the curriculum products of NRS serve as data for the analysis. Task analysis makes the detection of instructional strategies possible. Explicit listing and grouping of strategies make generalizing about these strategies possible. Generalizations about how to instruct in reading are, in fact,

principles of instruction. Performing this analysis of instructional sequences in NRS has revealed some explicit prescriptive principles for reading acquisition.

Results: Instructional Strategies in NRS

Results are reported in terms of both curriculum variables and variables at the level of an instructional event. Sequencing is assessed by the blackout technique. Analysis of Progress Checks gives information on students' errors and on the degree of individualziation.

Strategies Related to Curriculum Variables

The analysis of the NRS program indicates that the structure of the discipline of learning to read is a set of relationships (correspondences) between printed textual units and spoken language patterns. By consistent variation of the presentation elements, the child learns to deal with a variety of graphemic and syntactic units in order to read well. For example, within the first 25 Lessons in NRS, the learner progresses from the identification of single letter/sound correspondences to the decoding of short, simple sentences. The basic reading acquisition task in NRS is the transfer from the use of exclusively auditory symbols for language comprehension to the use of visual symbols for the comprehension of the same message. This first occurs in the teacher-led sequences where there is a transfer from an auditory to a graphemic stimulus. In NRS, the algorithm serves to teach what is probably the most difficult task of the learning-to-read process, the blending of sounds into words and the acquisition of the concept of a word. Mastery behavior in NRS is a relative term. Within the first six Levels of NRS mastery behavior consists of the unprompted application of the skills contained in the blending algorithm. Comprehension mastery includes a large recognition vocabulary presented within the context of various types of syntactic patterns.

Upon entering NRS, the learner is presumed to have the skills associated with competence in oral language at age five or six. The use of imitation or modeling in the early sequences takes advantage of the skills already in the

learner's repertoire. As the Lessons in NRS progress, units or tasks that were once quite distinct become grouped into larger units. This is a principle running through the entire program.

Strategies Related to Basic Learning Cycle Variables

The discriminative stimuli for decoding are graphemic units and, later, syntactic units of various sizes. For comprehension, the units are words and varieties of syntactic patterns. Questions are used in NRS to focus the attention of the learner on specific syntactic patterns. The basic strategy for the selection of graphemic stimuli in NRS is to present to the learner only those units which follow the alphabetic principle. Presentation of "sight words" is an exception to this, and prepares the learner for variations from the norm. Strategies in NRS for stimulus presentation include stimulus pairing, sharpening of stimulus control by presenting the discriminative stimulus in context, matching to sample, prompting and fading of prompts, and the use of both formal and thematic prompts. (See Sample Lesson 1)

The fundamental inferred response throughout the decoding strand is the simple association. Covert interaction of the learner is facilitated in several ways: limiting the number of associations to be learned at a given time, placing easily confused associations at a distance, introducing only one sound at a time for a given grapheme, and the use of diacritical marks for vowels that would otherwise look alike. Discriminations are prompted, practiced and introduced with contrast. There are strategies to promote generalization, and strategies to facilitate memory.

Written responses, limited to marking of various types (not script), are indications that the desired covert response has occurred. Application of the "blackout technique", a method for measuring the extent to which responses are dependent upon the content or inferred responses of the program, shows that the contingencies for the critical response are, for the most part, met. Sev-

eral strategies related to responses are employed in NRS: rehearsal of new responses in the immediate follow-up of workbook pages, use of oral responses already in the learner's repertoire, gradual raising of the acceptable level of correct response by successive approximations, shaping of responses by differential reinforcement, and fading of prompts until the response is produced independently. (See Sample Lesson 2)

To complete the three-term contingency, the response must be "sensed" in some way. In NRS, much evaluation must be self-evaluation by the learner. In cassette-led instruction, the responses can only be corrected or confirmed. However, great attention has been given to the strategy of providing appropriate feedback to the learner on the tape so that he will know if the response was correct.

NRS makes ample use of intermittent reinforcement as a strategy once the learner has acquired the basic skills of a sequence. Other types of reinforcement include: (1) artistic and pleasing arrangement of pages; (2) immediate feedback of knowledge of results; (3) the possibility of a high level of success.

Contingency Management and Assessment of Effects

Analysis of the contingent relationships built into the instructional materials was made by using the blackout technique (Holland, 1967). This is a method for measuring the extent to which the responses in a self-instructional program are dependent on the content (inferred responses) of the program. This technique was applied to the various sequences analyzed, without, however, completing the process by a validation of the judgments made. Where variations from an acceptable low blackout ratio occurred, recommendations were made either to revise the sequence or to justify the high blackout ratio in some way.

Empirical validation of these findings on student errors and student progress is necessary. It seems from the data that redundancies in the materials

might be further eliminated for faster learners. Attention should also be given to the mode of correction of errors. Empirical data should give accurate information about the degree of attention to text required in NRS.

Conclusions

It is through the instructional strategy that learning theory enters the classroom. This study demonstrates and makes more explicit one designer's mode of introducing behavioral learning principles into the sequences of a structured curriculum. The analysis makes evident four main principles of instruction: (1) making explicit use of knowledge about the capabilities of the learner for whom the materials have been designed; (2) structuring language units so that they can be readily grasped by the learner; (3) identifying a progression of effective sequence types; and (4) specifying the contingencies of reinforcement.

The greatest contribution of this particular curriculum to knowledge of instruction in reading acquisition is the careful identification and sequencing of stimuli for learning to read, together with contingencies which focus attention on these stimuli. The greatest weakness of NRS lies in the lack of a complete "sensing" unit for evaluation of student responses in a continuous manner. The design task analysis, as elaborated in the materials, displays a good "match" with experimental task analyses described in the literature of research on reading acquisition. Still more precise measures need to be applied to the sequences of NRS to indicate the predictability of the strategies described.

Specifically, the results show that a successful relationship has been established by design between how things are presented to the learner and how they are learned. The design does incorporate a theory of instruction. This theory is presented as a set of principles for instruction in reading acquisition (see Appendix, Tables 1 and 2)

Educational Implications

This study has addressed the issue of quality instruction. Curriculum investigations in the past have been directed mainly toward understanding the effects of instructional conditions on achievement. This study, instead, looks at the instructional conditions themselves. If underlying principles can be articulated clearly enough, successful procedures may be replicated by other designers. This study has presented some of these principles and a method for identifying them within structured curriculum products.

The power of the design of NRS lies in the clear identification of operants defined by the three-term contingency: stimulus, response, and reinforcement. Construct validity of an instructional program can be established by means of these identifications. Quality instruction in the future may be provided by producing validated instructional sequences for specified groups of learners. The production and analysis of NRS is a move in this direction.

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Table 1

Instructional Principles Related to Reading Skills

1. Those relating to the use of knowledge about the capabilities of the learner
   (a) Develop language skills which are weak like segmentation (applied to words and word patterns), association of sounds and symbols, and sound matching.
   (b) Use natural syntax to enhance reading ability.
   (c) Provide an organizational structure for bringing sound and symbol together.
2. Those relating to structuring the units of knowledge (in NRS, language units) so that they can be readily grasped
   (a) Provide for stimulus identification by presenting stimuli first in isolation and then very soon afterwards in context.
   (b) Use as stimuli the regular elements of language first so as to avoid heavy tax on memory.
   (c) Teach the reading of large graphemic units; do not limit the instruction to small or isolated graphemic units.
   (d) Parallel auditory discrimination with visual discrimination; use the teacher's voice in early instruction and a taped voice in later instruction.
   (e) "Force" the reader's attention onto a variety of structural patterns, including longer and more complex sentences.
3. Those relating to the identification of a progression of effective sequence types
   (a) Group instructional sequences according to the response types required of the learner; i.e., perform a task analysis at the theoretical level.
   (b) Provide ample practice so that the learner will generalize across individual instructional sequences to the rule that graphemic units form patterns that translate into sounds already known in spoken language.

(c) Present all types of language patterns as early as possible in their simplest form.

(d) Do not presume that the learner has the responses needed; provide for the teaching of the needed responses.

4. Those relating to contingencies of reinforcement

(a) Employ already known responses.

(b) Match decoding rules with grammar rules when designing the language formats to be read.

(c) Focus the learner's attention on the relevant stimuli.

(d) Link available vocal responses to concrete stimuli on the printed page and reward behavior for identifying such stimuli.

(e) Make attention to language elements a contingency for reinforcement.

Table 2

Instructional Principles Related to the Management of Instruction

1. Provide a problem-solving rule (algorithm) for the previously identified difficult tasks of the skill to be taught.

(a) MRS provides the blending algorithm for what is probably the most difficult task for the beginning reader, combining sounds to make a word.

2. Provide for task analysis at the level of programming variables. This enables the designer to build skill in a cumulative manner by gradually increasing the complexity of the sequence without changing the basic nature of the task.

3. Provide for implementing the law of effect by making the reinforcement contingent on production of the critical response.

4. Provide for concept formation by providing many examples of the concept to be learned. The large number of short instructional sequences in MRS serve this purpose.

SAMPLE LESSON 1
NRS Cassette-led Lesson for Level III

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The entire page is a formal prompt for guiding the learner through the Lesson.

1.

[Picture is used as a thematic prompt.]

2. peach chin

3. Sam can patch the tent.

[Underlining is a formal prompt.]

4. ch

[The S^D (discriminative stimulus) presented again in isolation.]

5. teach
tea_ _

[Matching to sample]

6. peach
cheap

[D
S occurring in both final and initial position.]

7. bench

2

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SAMPLE LESSON 2
NRS Workbook follow-up page for Level VI

306

Questions on this page "force" the reader's attention onto a variety of syntactic patterns both in isolation and in context.

4-3

Stan is going to the story to get some candy. Catman is with him. Catman sees a puppy. Catman leaps into Stan's arms. Stan laughs at Catman. He thinks Catman is funny because Catman is a lot bigger than the puppy.

1. What will Stan get at the story?
   - ☐ some corn
   - ☐ some candy

2. When does Catman leap into Stan's arms?
   - ☐ when he sees a bird
   - ☐ when he sees a puppy
   - ☐ when he wants some candy

3. What does Stan do when Catman leaps into his arms?
   - ☐ He whispers.
   - ☐ He laughs.
   - ☐ He runs.

4. Why does Stan think Catman is funny?
   - ☐ because the puppy is bigger than Catman
   - ☐ because Catman is bigger than the puppy

%

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[If there are any errors, read the story aloud with the child. The... through each question outlined, each time asking the child to find the part of the text where the answer is found.]

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